

# *XMM-Newton* and *INTEGRAL* observations of the very faint X-ray transient IGR J17285–2922/XTE J1728–295 during the 2010 outburst

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## ABSTRACT

We report the first broad-band (0.5–150 keV) simultaneous X-ray observations of the very faint X-ray transient IGR J17285–2922/XTE J1728–295 performed with *XMM-Newton* and *INTEGRAL* satellites during its last outburst, started on 2010, August 28. *XMM-Newton* observed the source on 2010 September 9–10, for 22 ks. *INTEGRAL* observations were part of the publicly available Galactic Bulge program, and overlapped with the times covered by *XMM-Newton*. The broad-band spectroscopy resulted in a best-fit with an absorbed power law displaying a photon index,  $\Gamma$ , of  $1.61 \pm 0.01$ , an absorbing column density,  $N_H$ , of  $(5.10 \pm 0.05) \times 10^{21} \text{ cm}^{-2}$ , and a flux of  $2.4 \times 10^{-10} \text{ erg cm}^{-2} \text{ s}^{-1}$  (1–100 keV), corrected for the absorption. The data did not require either a spectral cut-off ( $E_c > 50 \text{ keV}$ ) or an additional soft component. The slopes of the *XMM-Newton* and *INTEGRAL* separate spectra were compatible, within the uncertainties. The timing analysis does not show evidence either for X-ray pulsations or for type I X-ray bursts. The broad band X-ray spectrum as well as the power density spectrum are indicative of a low hard state in a low mass X-ray binary, although nothing conclusive can be said about the nature of the compact object (neutron star or black hole). The results we are reporting here allow us to conclude that IGR J17285–2922 is a low mass X-ray binary, located at a distance greater than 4 kpc.

**Key words:** X-rays: individual (IGR J17285–2922, XTE J1728–295)

## 1 INTRODUCTION

Very faint X-ray transients (VFXTs) display outburst peak luminosities in the range  $10^{34}$ – $10^{36} \text{ erg s}^{-1}$  (2–10 keV), almost two or three orders of magnitude fainter than the emission typically shown by most Galactic X-ray transients (Wijnands et al. 2006). This, together with their apparently small duty cycles, suggests that these black holes or neutron stars in binary systems undergo a very low average accretion rate (King & Wijnands 2006).

To date, about 30 VFXTs are known and they very likely form a non-homogeneous class of objects, because their only common feature is the low luminosity. About one third exhibit type-I X-ray bursts (Del Santo et al. 2007, 2010) and can thus be identified with neutron stars accreting matter from a low mass companion, but the nature of the remaining sources is unknown (Degenaar & Wijnands 2009).

IGR J17285–2922 is a hard transient discovered in the direction of the Galactic bulge with *INTEGRAL* in 2004 (Walter et al. 2004). The source underwent an outburst lasting at least two weeks with a peak flux of  $1.1 \times 10^{-10} \text{ erg cm}^{-2} \text{ s}^{-1}$  (20–150 keV)

(Barlow et al. 2005). For an assumed distance of 8 kpc, this corresponds to a luminosity of  $8 \times 10^{35} \text{ erg s}^{-1}$ , which led to classify IGR J17285–2922 as a VFXT.

More recently, Markwardt & Swank (2010) reported on a renewed X-ray activity started on August 28th, 2010, from a transient previously named XTE J1728–295. Given the positional coincidence, they suggested that XTE J1728–295 and IGR J17285–2922 are the same source. *INTEGRAL* observations confirmed the renewed activity of XTE J1728–295 and its association with IGR J17285–2922 (Turler et al. 2010).

Following this outburst, we triggered a *XMM-Newton* ToO observation, with the main aim of an in-depth investigation of the nature of this source. The observation was performed on 2010 September, 9–10, about 13 days after the on-set of the outburst. We also analyzed *INTEGRAL* data of the source field obtained, as part of the publicly available Galactic Bulge program<sup>1</sup> (Kuulkers et al. 2007), overlapping with the *XMM-Newton* observations.

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<sup>1</sup> <http://isdc.unige.ch/Science/BULGE/>

## 2 OBSERVATIONS AND DATA REDUCTION

### 2.1 *XMM-Newton*

The *XMM-Newton* Observatory (Jansen et al. 2001) carries three 1500 cm<sup>2</sup> X-ray telescopes, each with EPIC imaging spectrometers at the focus. Two of the EPIC use MOS CCDs (Turner et al. 2001) and one uses a pn CCD (Strüder et al. 2001). RGS arrays (den Herder et al. 2001) are located behind two of the telescopes.

IGR J17285–2922 was observed with *XMM-Newton* on 2010 September 9–10. EPIC pn operated in Large Window mode, while both MOS cameras were in Full Frame mode, with all the CCDs in Imaging mode. Both MOS and pn observations used the medium thickness filter.

*XMM-Newton* data were reprocessed using version 10.0 of the Science Analysis Software (SAS). Known hot, or flickering, pixels and electronic noise were rejected. The background (selected with PATTERN=0 and above 10 keV) did not show evidence of flaring activity, so no further temporal selection was applied, resulting in net exposures times of 18.5 ks and 21.6 ks, respectively for pn and MOS. Extraction radii of 40'' and 1' were used for the source spectra, respectively for the pn and MOS cameras. Background counts were obtained from similar sized region offset from the source position, resulting in a net count rate of  $10.65 \pm 0.024$  counts s<sup>-1</sup> in the pn spectrum. Response and ancillary matrix files were generated using the SAS tasks RMFGEN and ARFGEN. Using the SAS task EPATPLOT we found that only the MOS spectra were affected by pile-up. Thus, we excluded the inner 6'' (radius) of the PSF from the MOS1 and MOS2 spectra adopting only PATTERN=0, while for EPIC pn spectrum we selected PATTERN from 0 to 4.

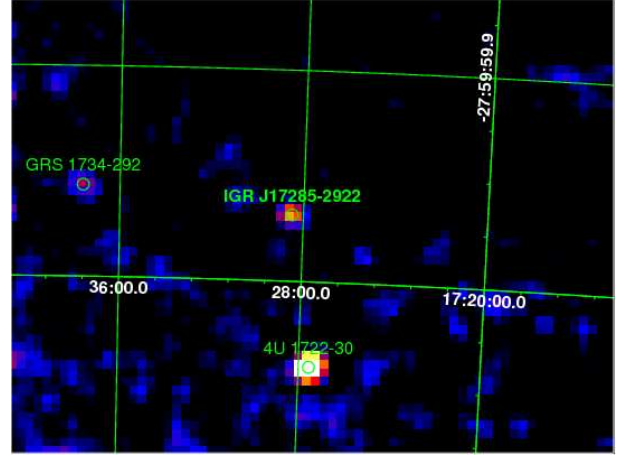
To ensure applicability of the  $\chi^2$  statistics, the net spectra were rebinned such that at least 20 counts per bin were present and such that the energy resolution was not over-sampled by more than a factor 3. All spectral uncertainties and upper-limits given below are at the 90% confidence level for one parameter of interest. We performed the data analysis using HEASoft 6.10 and XSPEC v.12.

The RGS was operated in spectroscopy mode and resulted in a net exposure of 21.6 ks. RGS source and background events were calibrated by applying the latest calibration parameters.

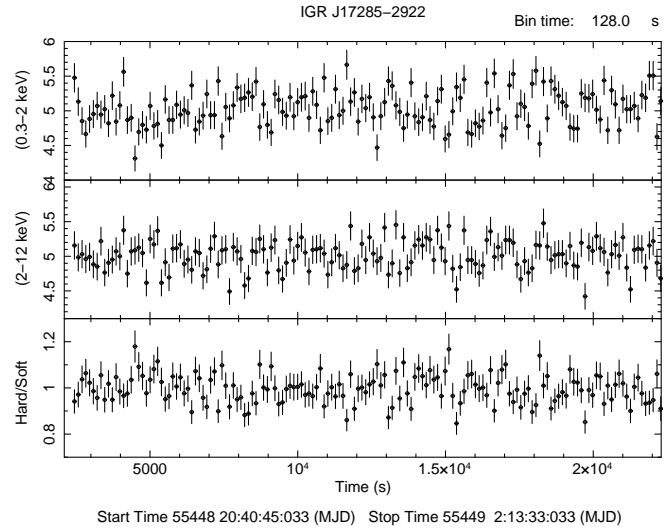
### 2.2 *INTEGRAL*

We analyzed the data of the Galactic Bulge monitoring program in the time-frame close to the source outburst as detected by *RXTE* on August 28th, 2010. We used the imager IBIS/ISGRI (Ubertini et al. 2003, Lebrun et al. 2003) on-board *INTEGRAL* (Winkler et al. 2003), and analyzed a total of 68 pointings, each with an exposure time of about 1800 s (nominal), spanning from August 26, 2010 to October 6, 2010.

Version 9.0 of the Off-line Scientific Analysis (OSA) software was used to analyse the data. For each pointing we extracted images in the 17.8–25, 25–30.2, 30.2–50.3, 50.3–80, 80–150.4 keV energy bands (the boundaries have been chosen in order to cope with the response matrix). The images were used to build one-pointing based light-curves as well as a final mosaic. The source has never been detected at a single pointing level, or at a one mosaic per revolution level, but it is clearly detected in the total mosaic (see Fig 1). We extracted an average spectrum from the total mosaic using the MOSAIC\_SPEC tool available within the OSA 9.0 software package.



**Figure 1.** ISGRI significance map obtained in the 30.2–50.3 keV band. IGR J17285–2922 is detected with a significance of about 7.5



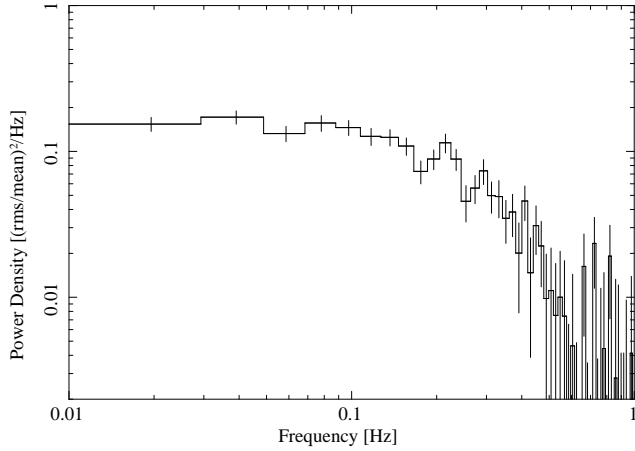
**Figure 2.** IGR J17285–2922 light curve with EPIC pn in two energy ranges (below and above 2 keV) and their hardness ratio. Bin time is 128 s.

## 3 ANALYSIS AND RESULTS

### 3.1 Light curves and Timing Analysis

The light curves of IGR J17285–2922 observed with the EPIC pn in the soft (0.3–2 keV) and hard (2–12 keV) energy ranges are shown in Fig. 2. A similar behaviour is displayed by source emission observed with both MOS1 and MOS2. The average flux does not vary during the observation, but some rapid variability is present. This is clearly visible in the power spectrum shown in Fig. 3, which has been obtained by averaging the power spectra (0.3–12 keV) of 391 time intervals of 51.2 s each, binned at 0.1 s. The fractional rms variability, integrated over the 0.01–1 Hz range, is about 20%.

The hardness ratio between the soft and hard energy ranges (bottom panel of Fig. 2) is consistent with a constant value. A fit with a constant gives a value of  $0.989 \pm 0.004$  ( $\chi^2_\nu = 1.27$  for 156 d.o.f.). Therefore in the following we perform a spectral analysis integrating over the whole duration of the observation.



**Figure 3.** Power spectrum of EPIC pn source events in the energy range 0.3–12 keV.

The low statistics hampers a meaningful temporal analysis at hard energies, since the source is not detected in single pointings, but only in the total mosaic of the summed IBIS/ISGRI observations (see Section 2.2).

### 3.2 Spectroscopy

Fitting the EPIC spectra (pn+MOS1+MOS2) with an absorbed power law resulted in structured residuals near 2.2 keV and below 1 keV, which can be ascribed to residual uncertainties in the calibration. The largest departure of the data with respect to the model is due to narrow negative residuals near 2.2 keV present in the EPIC pn, likely due to an incorrect instrumental modeling of the gold mirror edges, as already noticed, for example, in the *XMM-Newton* spectrum of GRO J1655-40 (Díaz Trigo et al. 2007). The other discrepancies present around and below 1 keV have often been observed in other X-ray binaries, especially in case of hard X-ray emission (e.g. Boirin et al. 2005, Sidoli et al. 2005, Sidoli et al. 2008). Some authors usually exclude the softest part of EPIC data, other include Gaussian lines to account for these residuals (e.g. Díaz Trigo et al. 2007). Here we decided to not exclude particular energy ranges, but instead to include a 2% systematic error in EPIC data, both when fitting the EPIC spectra alone (pn+MOS1+MOS2), and when fitting them together with ISGRI higher energy spectrum. Other authors adopted similar or even higher systematic errors (Cadolle Bel et al. 2004) to account for these residual discrepancies. Note however that, if we perform the spectroscopy only considering the higher energy range 2.5–10 keV (EPIC data), the resulting spectral parameters are always consistent with the results we are reporting in the following paragraphs.

The spectroscopy of the EPIC data alone (0.5–10 keV) with an absorbed power law ( $\chi^2_\nu = 1.094$  for 640 d.o.f.) resulted in the following parameters:  $N_H = (5.10 \pm 0.05) \times 10^{21} \text{ cm}^{-2}$ , photon index,  $\Gamma$ , of  $1.61 \pm 0.01$ . Adopting alternative simple models resulted in much worse fits: a multicolour disk blackbody (DISKBB in XSPEC) or a simple blackbody gave  $\chi^2_\nu > 5$ . Additional soft components to the power law model, as well as a high energy exponential cut-off, were not required by the data. Other complex fits, e.g. a multicolour disk blackbody (DISKBB in XSPEC) plus a blackbody, although formally acceptable ( $\chi^2_\nu = 1.100$  for 638 d.o.f.), underestimated the flux

seen higher energies with *INTEGRAL*, thus requiring an additional hard power law component.

The RGS spectra (0.5–2 keV) resulted in net source count rates of  $0.150 \pm 0.003 \text{ counts s}^{-1}$  and  $0.192 \pm 0.003 \text{ counts s}^{-1}$  respectively in RGS1 and RGS2. RGS spectra did not show evidence for narrow lines. An absorbed power law was a good fit to the data ( $\chi^2_\nu = 0.918$  for 3038 d.o.f.) resulting in a column density in the range  $[0.57\text{--}0.77] \times 10^{22} \text{ cm}^{-2}$  and a photon index,  $\Gamma$ , between 1.48 and 2.10 (90% uncertainty). This is consistent with the EPIC results, so we will not discuss the RGS data further.

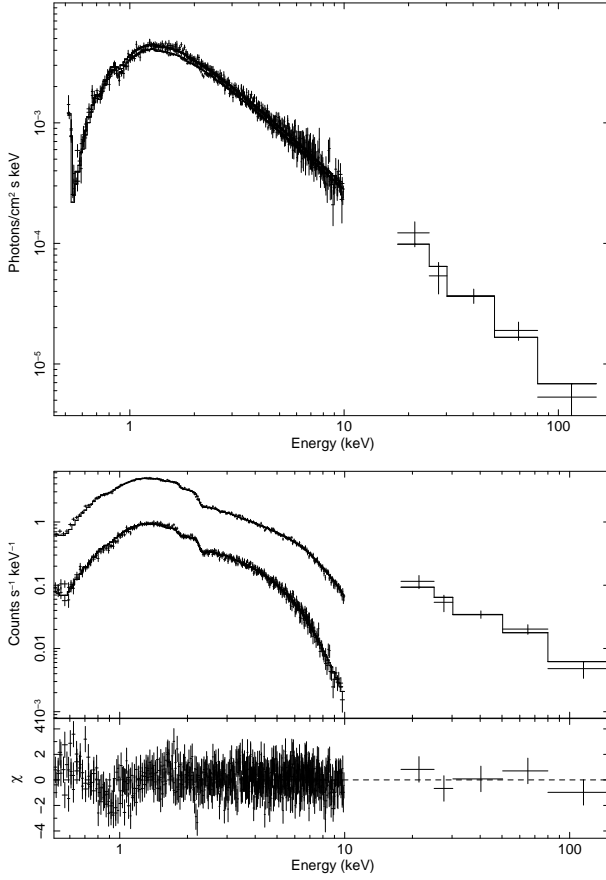
The *INTEGRAL*/ISGRI spectrum (17.8–150.4 keV) displayed a slope consistent with the one seen with *XMM-Newton* below 10 keV: a fit with a power law resulted in a photon index of  $1.7 \pm 0.3$  ( $\chi^2_\nu = 0.742$  for 3 d.o.f.).

We next analysed the broad band 0.5–150 keV emission with a joint fit of *XMM-Newton*/EPIC (pn+MOS 1+MOS 2) and *INTEGRAL*/ISGRI. We included constant factors in the spectral fitting to allow for normalization uncertainties between the instruments. An absorbed power law model resulted in a good fit ( $\chi^2_\nu/\text{d.o.f.} = 1.091/644$ ), as shown in Fig. 4. The best-fit spectral parameters are equal to those obtained for the EPIC spectrum alone and the ISGRI/EPIC pn constant factor was  $1.17 \pm 0.18$ . The fluxes corrected for the absorption are the following:  $F = 6.8 \times 10^{-11} \text{ erg cm}^{-2} \text{ s}^{-1}$  and  $F = 2.4 \times 10^{-10} \text{ erg cm}^{-2} \text{ s}^{-1}$ , respectively in the 1–10 keV and 1–100 keV energy ranges (assuming the EPIC pn response matrix extrapolated to higher energies). Fitting the EPIC and ISGRI data with a power law with a high-energy exponential cut-off (CUTOFFPL model in XSPEC) allows us to put a lower limit to the cut-off energy,  $E_c$ , of  $\sim 50 \text{ keV}$  (Fig. 5, 90% confidence level).

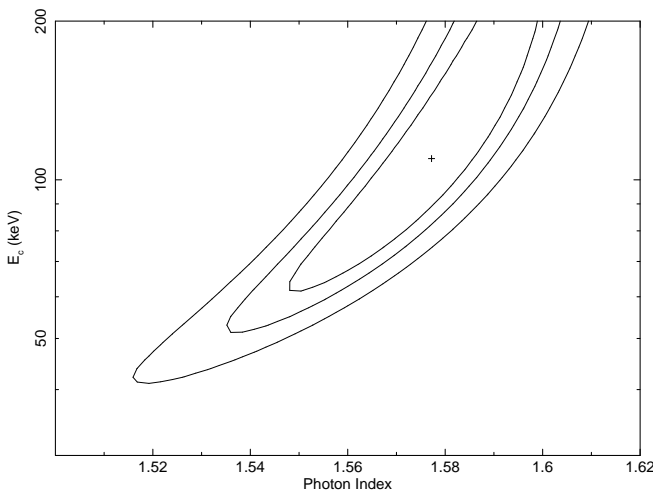
We also tried a double component model, adding a soft component to the power law continuum: using a blackbody together with a power law, we obtained a blackbody temperature of  $0.61^{+0.86}_{-0.07} \text{ keV}$  and a small radius  $R_{bb} = 0.80^{+0.46}_{-0.38} \text{ km}$  (at a distance of 8 kpc;  $\chi^2_\nu/\text{d.o.f.} = 1.082/642$ ). An F-test resulted in a probability of  $2.631 \times 10^{-2}$ . Similar results were obtained assuming a DISKBB model for the additional component ( $\chi^2_\nu/\text{d.o.f.} = 1.080/642$ ; F-test probability of  $1.187 \times 10^{-2}$ ), resulting in an inner disc temperature of  $1.2^{+2.0}_{-0.3} \text{ keV}$  and in an innermost disc radius,  $R_{in} \times (\cos i)^{0.5}$ , of  $0.20^{+0.31}_{-0.09} \text{ km}$  at 8 kpc ( $i$  is the disc inclination). Therefore we conclude that, even if we cannot rule out the presence of a weak additional soft component, there is no statistical evidence for its presence in the current data.

We next tried to describe the broad-band spectrum with physical models which involve a Comptonizing plasma, like COMPTT and BMC in XSPEC. A fit with the COMPTT model (Titarchuk 1994) returns a scenario with cold seed photons (0.05–0.09 keV) upscattered by a corona (disc geometry) with optical depth  $\tau = 1.5^{+0.5}_{-1.4}$  and electron temperature  $kT_e > 20 \text{ keV}$  ( $\chi^2_\nu/\text{d.o.f.} = 1.080/642$ ).

We also fit the data with the BMC model (Titarchuk et al. 1996). This model is the sum of a blackbody (BB) plus its Comptonization, the latter obtained as a consistent convolution of the BB itself with Green’s function of the Compton corona. The free parameters of the BMC model (apart from the normalization) are the BB colour temperature,  $kT_{BB}$ , the spectral energy index,  $\alpha$ , and the logarithm of the illuminating factor A,  $\log A$ . The  $\log A$  parameter is an indication of the fraction of the up-scattered BB photons with respect to the BB seed photons directly visible. In the extreme cases, the seed photons can be completely embedded in the Comptonizing cloud (none directly visible,  $A \gg 1$ , e.g.  $\log A = 8$ ) or there is no coverage by the Compton cloud ( $A < 1$ , e.g.  $\log A = -8$ ), and we directly observe the seed photon spectrum (equivalent to



**Figure 4.** 0.5–150 keV broad band spectrum of IGR J17285–2922 (pn+MOS1+MOS2 together with ISGRI data), fitted with an absorbed power law model. *Upper panel* shows the photon spectrum, while the *lower panel* displays the counts spectrum together with the residuals in units of standard deviations.



**Figure 5.** Confidence contour levels (68%, 90%, 99%) for the two parameters high energy cut-off,  $E_c$ , and photon index, when fitting the broad band spectrum with an absorbed cut-off power law (CUTOFFPL model in XSPEC).

a simple BB, with no Comptonization). In our case we obtain ( $\chi^2/\text{d.o.f.}=1.027/642$ ) a  $kT_{\text{BB}}=0.07^{+0.03}_{-0.01}$  keV, seed photon population up-scattered with  $\alpha=0.64\pm0.02$  and  $\log(A)=-0.24^{+0.02}_{-0.1}$ . We note that the BMC model has no cut-off in it (i.e. we are in the power-law shape case) and the well constrained  $\alpha$  parameter ( $\Gamma=\alpha+1$ ) indicates the overall Comptonization efficiency related to an observable quantity in the photon spectrum of the data (the slope  $\alpha$ , unlike  $kT_e$  and  $\tau$  that are not directly observable in the spectrum). The lower the  $\alpha$  value, the higher the efficiency, that is, the higher the energy transfer from the hot electrons to the soft seed photons.

#### 4 DISCUSSION AND CONCLUSIONS

Our *XMM-Newton* ToO observation of IGR J17285–2922/XTE J1728–295 triggered by its recent outburst, coupled with simultaneous INTEGRAL data, allowed us to derive the first broad band spectrum (0.5–150 keV) of this VFXT. During this outburst, the second shown by this source in almost seven years, follow-up observations were carried out with different satellites and ground based telescopes. The source position was first refined thanks to a *Swift*/XRT pointing (Yang et al. 2010). This ruled out all the six sources detected with *Chandra* in the *INTEGRAL* error circle when IGR J17285–2922 was in quiescence (Tomsick et al. 2008) as possible soft X-ray counterparts. A sub-arcsecond position was later determined with *Chandra* (Chakrabarty et al. 2010), leading to the identification of a likely optical counterpart (Russell et al. 2010, Torres et al. 2010, Russell et al. 2010, Kong et al. 2010). This star, at coordinates R.A. (J2000) =  $17^h 28^m 38.86^s$ , Dec (J2000) =  $-29^\circ 21' 44.0''$  (Torres et al. 2010), appeared bluer and more variable than other candidates inside the *Chandra* error region. It was not detected in archival optical images taken three months before the last outburst, with an upper limit of R-magnitude  $>21$  (Kong et al. 2010).

The faintness of the optical counterpart in quiescence allows us to better constrain the source nature and its distance. In the following, we use a visual extinction  $A_V=2.4$  mag (which implies  $A_R=1.8$  mag), derived from the absorbing column density resulting from the X-ray spectroscopy (Güver & Özel 2009).

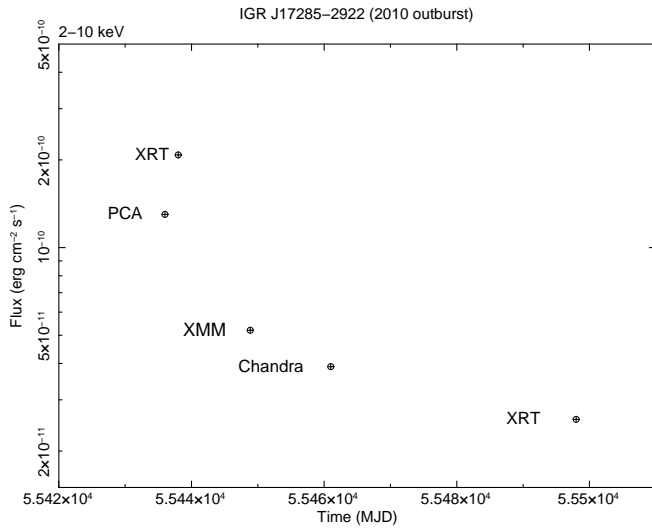
A HMXB can be excluded, because, even if placed at the Galactic boundaries, it would have a brighter R magnitude. For example, to have  $R>21$  mag, a B0V star should lie at a distance larger than 450 kpc, and a B0.5 supergiant star at more than 1.6 Mpc. The source is more likely a LMXB, being fully compatible with the observed constraint: for example, a K5V companion star (assuming  $M_V=+7.3$ ,  $V-R=+0.99$ ; Johnson 1966), placed at 8 kpc, would show a magnitude  $R\sim 22-23$ . On the other hand, the measured upper limit  $R>21$  mag would imply a LMXB distance larger than  $\sim 4$  kpc. Thus, we conclude that IGR J17285–2922 is a LMXB located at a distance greater than 4 kpc.

During its first outburst in 2003, IGR J17285–2922 was caught at first in a soft state with the *RXTE* satellite, consistent with a steep power law with a photon index of 3.6–3.8 (Markwardt & Swank 2010). Then, during *INTEGRAL* observations performed about one month later, the 20–150 keV spectrum seemed to be harder, with  $\Gamma=2.1\pm0.17$  (Barlow et al. 2005).

During the evolution of the second outburst in 2010 (see Table 1 and Fig 6), the source spectrum was apparently harder when fainter, with a continuum always dominated by a power law with a slope within the canonical range for the low-hard state in LMXBs ( $\Gamma\sim 1.5-1.7$  for BH binaries, hereafter BHB, Belloni (2010)). This

**Table 1.** Summary of the published observations of IGR J17285–2922 performed during the 2010 outburst.

Time (YYYY-MM-DD)	Energy band (keV)	Unabsorbed Flux $10^{-10}$ erg cm $^{-2}$ s $^{-1}$	Power law $\Gamma$	Column density $10^{21}$ cm $^{-2}$	Refs.
2010-08-28	2–10	1.3	—	—	Markwardt & Swank (2010)
2010-08-30	0.3–10	6.1	$2.23 \pm 0.26$	$5.4 \pm 1.2$	Yang et al. (2010)
2010-08-26/30	20–80	0.98	$2.1 \pm 0.5^a$	—	Turler et al. (2010)
2010-09-09/10	2–10 (0.3–10)	0.54 (0.86)	$1.61 \pm 0.01$	$5.10 \pm 0.05$	<i>This work</i>
2010-09-22	0.1–10	1.6	2.23 fixed	5.4 fixed	Chakrabarty et al. (2010)
2010-10-29	0.3–10	0.46	$1.7 \pm 0.2$	$6.2^{+1.4}_{-1.2}$	Yang et al. (2010)

<sup>a</sup> 1  $\sigma$  error.

**Figure 6.** Evolution of the 2010 outburst. Absorbed fluxes in the energy range 2–10 keV have been calculated from the best-fit parameters reported in Table 1, except for the *XMM-Newton* observation, where we show the observed 2–10 keV flux obtained from our EPIC spectroscopy.

behavior (low-hard state during the entire outburst) is consistent with a BH nature, although the canonical evolution of the outburst in a BH transient (BHT) starts with a low-hard state and then undergoes a transition to a high-soft state, where the thermal emission from the accretion disc dominates the X-ray spectrum, following a q-shaped behavior in the hardness-intensity diagram (see the recent review Belloni 2010 and references therein). However, not all BHTs go through low-hard to high-soft states during their outbursts, but a few of them remain in the low-hard state until they return to quiescence (see, e.g., Brocksopp et al. 2004, Capitanio et al. 2009).

The IGR J17285–2922 broad-band X-ray spectrum we have reported here, if fitted with physical models (see Section 3.2), draws a scenario compatible with the typical low hard state of a LMXB (cold and distant disc Comptonized by a hot corona), but little can be said from the spectral point of view on the nature of the compact object, since a plasma temperature of  $kT_e > 20$  keV (and  $\Gamma = \alpha + 1 = 1.6$ ) has been observed in both BH and neutron star LMXBs (e.g. Paizis et al. 2006, Bouchet et al. 2009, Cocchi et al. 2010).

Observations suggest that quiescent BHTs as a class are fainter than transients containing a neutron star with similar orbital periods (Garcia et al. 2001, Narayan & McClintock 2008). Tom-

sick et al. (2008) found six faint sources within the *INTEGRAL* error circle during a *Chandra* observation when the source was in quiescence, thus leading to an unclear counterpart. Taking the brightest of these faint *Chandra* sources, they calculated a conservative upper limit to the X-ray emission in quiescence of  $5.5\text{--}6.4 \times 10^{-14}$  erg cm $^{-2}$  s $^{-1}$  (0.3–10 keV unabsorbed flux, assuming power law photon indices between  $\Gamma=1$  and 2). A refined error circle allowed to exclude (Yang et al. 2010), as possible soft X-ray counterparts, all these six *Chandra* sources. Thus we can re-calculate these upper limits to the quiescent emission, rescaling these fluxes at least to the faintest *Chandra* source in the error circle, resulting in a new upper limit of  $2.4\text{--}2.8 \times 10^{-14}$  erg cm $^{-2}$  s $^{-1}$  (0.3–10 keV, unabsorbed flux, assuming  $\Gamma=1\text{--}2$ ). This translates into an X-ray luminosity in quiescence  $L_{\text{quiesc}} < (1.7\text{--}2.0) \times (d_{\text{skpc}}^2) \times 10^{32}$  erg s $^{-1}$ , where  $d_{\text{skpc}}$  is the source distance in units of 8 kpc. If IGR J17285–2922 is located closer than the Galactic Centre, this conservative upper limit to the quiescence becomes low and possibly indicative of a BHB.

Neither X-ray pulsations nor type I X-ray bursts have been observed. The power density spectrum (PDS) measured with *XMM-Newton* resembles the typical shape and normalization of aperiodic variability in low-hard states of LMXBs (McClintock & Remillard 2006, Belloni 2010), but nothing really conclusive can be said about the nature of the compact object.

This observation, although leading to the first broad-band spectroscopy up to 150 keV, demonstrated that it is very difficult to discriminate a black hole from a neutron star in a VFXT. From the spectral point of view, it does not exist, to date, a firm spectral signature which allows to distinguish a black hole from a neutron star, especially if the X-ray transient remains in a low/hard state along the entire outburst. The same can be said about the power density spectrum in the frequencies range of our data: a possible way to distinguish a black hole from a neutron star was proposed by Sunyaev & Revnivtsev (2000), but it involves power density spectra at higher frequencies, above 500 Hz. Moreover, in VFXTs ( $\dot{M} < 2 \times 10^{-10} M_{\odot} \text{ yr}^{-1}$ ) hosting accreting neutron stars, the type I X-ray bursts seem to be rare (Cornelisse et al. 2004, Wijnands 2008), although a proper comparison with the different possible explanations (e.g. Peng et al. 2007) needs more observational data, especially on the bursts recurrence time at different accretion regimes.

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Member States and the USA (NASA). *INTEGRAL* is an ESA project with instruments and science data centre funded by ESA member states (especially the PI countries: Denmark, France, Germany, Italy, Switzerland, Spain), Czech Republic and Poland, and with the participation of Russia and the USA. The *INTEGRAL* data used in this paper are taken from the *INTEGRAL* Galactic bulge monitoring program (PI E. Kuulkers) that are publicly available and hence offer the unique opportunity to study broad-band spectra of active sources in the Galactic bulge, in a fruitful synergy of operating high energy missions. We thank the *XMM-Newton* duty scientists and science planners for making these observations possible, in particular Rosario Gonzalez-Riestra (*XMM-Newton* Science Operations Centre User Support Group). This work was supported in Italy by contracts ASI/INAF I/033/10/0 and I/009/10/0 and by the grant from PRIN-INAF 2009, “The transient X-ray sky: new classes of X-ray binaries containing neutron stars” (PI: L. Sidoli).

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